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EDITORIAL DEPARTMENT NOTE

Depreciation continues to be one of the most difficult problems with which the accountant has to deal. It has been complicated for the accountant by the necessity of having to reconcile the requirements of income tax regulations with the needs of management. In the past much consideration has been given to *methods* of depreciation through the various types of rates, but perhaps too little consideration has been given to what the author of the article in this issue of the *Bulletin* calls *systems* of depreciation. This article dealing with the group system represents a refreshing approach to the problem, and provides the basis for further consideration of the relative merits of the unit, composite and group systems of depreciation.

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Articles published in the *Bulletin* present many different viewpoints. In publishing them the Association is not sponsoring the views expressed, but is endeavoring to provide for its members material which will be helpful and stimulating. Constructive comments are welcomed and will be published in the Forum Section of the *Bulletin*.

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DECEMBER 15, 1941

THE GROUP SYSTEM OF DEPRECIATION

By Gay Carroll, Controller,
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Depreciation in General

Even though thousands of pages have been written and many more thousands of words spoken on depreciation, it nevertheless continues to be one of the most intriguing, yet baffling, subjects with which the accountant and businessman has to contend. Like the poor, it is always with us, hounding and excoriating us to do something about it.

Depreciation is as much a management problem as factory or office payroll. In reality it is the plant investment and equipment payroll. It is not enough that you sit idly by and let this inanimate payroll go blithely along without considering whether it is being overpaid or underpaid, or whether it should be fired altogether. True, the question of increasing or decreasing the depreciation payroll is directly the responsibility of management; however, you and I know it is the accountant who must provide management with such factual information as will permit him to decide policies affecting depreciation questions.

Systems of Accounting for Depreciation

We all know depreciation is a loss in service value of produced or constructed fixed, tangible properties. We know, too, that such loss is the result of age, use, obsolescence, inadequacy and exposure to the elements. We know further that depreciation accounting contemplates the classifications of physical assets accounts, the determination of rates, the computation and recording of current provisions, and the giving of effect to such computations in financial, cost and statistical reports. But, in addition to these things, depreciation accounting requires particularly the determination of what *system* of depreciation is to be followed.

At this point it seems germane to inquire what a *system* of depreciation is and how *systems* of depreciation may be distinguished from *methods* of depreciation. Almost every good textbook on accounting explains the various methods of computing depreciation. You will recognize them as the straight-line method,

the constant or fixed per cent of diminishing value method, the service-output method, the appraisal method, and many others. The method of computation, however, is only one aspect of a depreciation system. Most of the known methods may be applied as an integral part of any of the systems of depreciation. Other aspects are concerned with the problem of classification of assets as a basis of depreciation, determining and checking the rates to be applied, and application of details with respect to showing depreciation provisions on the records.

For the sake of convenience and for the want of better terms, systems of depreciation will be referred to as (1) the unit system, (2) the composite life system, and (3) the group system, each of which will now be defined and distinguished.

The unit system calls for the maintenance of book records of individual units of depreciable property with corresponding reserves. Obviously such a system is not practicable with many small units. Where, however, the unit is substantial in amount, such as a generator, a truck, an office building or a steamship, and where the unit cost of operation is required, such a system of depreciation is highly significant.

The composite-life system contemplates depreciating, as a unit, a number of mixed assets assembled to perform a particular service but with each such unit having a different life expectancy. A simple illustration would be that of a filling station with buildings, structures, and runways taking one rate, tanks and pumps another, grease racks perhaps another, and office equipment still another. Instead of applying individual rates to each of these types of assets, however, the composite-life system calls for determining the mean life of the station; that is, getting a rate weighted by the component parts making up the whole and applying this rate to the total cost of the station and its appurtenances. Another illustration would be that of a battery of distilling equipment which might include still settings, the actual stills, superstructure and walks, tanks, towers, exchangers, condensers and cooling coils, pumps and piping. The composite system, then, makes use of an operating assembly or an operating unit as a basis of depreciation rather than individual items of equipment entering into the assembly or the operating unit.

The group system, on the other hand, is broader and more inclusive, and calls for the assembling together of all assets of like characteristics and like expected lives. In its simplest application the group system may be said to assume the following: (1) an aggregation of homogeneous depreciable property; (2) the determination of depreciation periodically for the entire group of assets as though it were a unit; and (3) the maintenance of a single depreciation reserve account rather than separate reserve accounts for each of the units of property making up the group. As an example, all telephone poles of a telephone company might make up one group. The generators, the electric transmission lines, and the power buildings of an electric utility company might each constitute a group. If all the trucks of a bakery or an ice cream plant were kept together and depreciated as a unit, it may be said that those concerns were applying the group system. Trunk lines, gathering systems and office equipment (each of which would constitute a group) of a pipe line company, provide illustrations of this form of grouping. But in addition to grouping units of like characteristics, there may be groups of operating assemblies or operating units. Several batteries of stills, each having a composite rate, may make up a group. All of the field service units such as water systems, repressuring systems and gas system may each individually make up a group; or all of the field service units of a particular district may be placed together in order to get a rate applicable to all such field service units in a particular district.

Thus grouping may be either horizontal, vertical or geographical. It would be horizontal if all assets of like physical characteristics, such as tanks or locomotives, were grouped together. It would be a vertical or functional grouping if all the assets of a plant such as those pertaining to a refinery, a paper mill, or a machine shop were group together for purposes of depreciation. It would be geographical if the assets of the region, district or other geographical areas were grouped together. The last two named methods, namely, vertical and geographical, might be referred to as composites of composites. The names applied appear more descriptive.

Advantages Claimed for the Group System

Those who advocate the group system of depreciation support their contention with the following arguments:

1. The grouping of homogeneous properties and related reserves will tend to reduce the margin of error inherent in depreciation estimates by offsetting overdepreciation with underdepreciation of individual units.

2. Even though individual units may have varying useful lives, the operating life of all such units may be equally restricted by local operating or economic conditions. To the extent that these conditions exist, depreciable property may well be grouped and be depreciated as a group since the economic life of each unit is the same irrespective of its physical life. As an example, field service units in an oil company, such as water systems, gas systems, mud systems and the like, may well be grouped according to fields or districts and be depreciated in accordance with the life of the field or district served.

3. Less clerical work will be required to maintain plant and reserve accounts and to make current distributions and voucher analyses affecting depreciation sustained.

4. More practical cost distributions will result if depreciation is considered on an over-all basis, thus preventing, or at least failing to recognize, the so-called retirement losses which are usually carried directly to profit and loss and, therefore, never enter into cost allocations. There will thus be a smoothing out of direct profit and loss charges since practically all plant investments will be returned through depreciation charged into operation.

5. By the same token, budgeting is made simpler by having a reasonably accurate estimate of the average life of the group and not having to attempt the impossible task of estimating the date of retirement of each item of equipment and hence the amount of retirement loss or gain of each individual item of equipment owned.

6. Procedure under the group systems conforms more nearly with the present depreciation policy of the Bureau of Internal Revenue. Its adoption would make possible the elimination of duplicate depreciation records, thereby saving time and expenses

of making two sets of depreciation computations and keeping two depreciation reserve accounts reconciled.

These are some of the arguments for the group system. Many others are proposed. Fundamentally, however, adherents to the group system contend that since the probability of error in individual depreciation rates is admitted by all, no particular purpose is served by attempting to maintain individual provisions and reserves by units. The next best thing they claim is to let the errors average out by grouping. As a corollary of grouping, and since individual reserve accounts will not be maintained, losses from ordinary retirements of individual units will be charged against the group reserve. For example, assume a company has grouped all its 2,500 filling stations and has applied a depreciation rate of 4 per cent to the group. The cost of each individual station will be recorded on the books, but only one reserve account covering all the stations will be maintained. After ten years station No. 1575, costing $4,000 and located on X Highway, is abandoned by virtue of rerouting of traffic through Highway Y. Under the group system the entire $4,000, less salvage, and not the theoretical $1,600 of depreciation would be charged against the reserve account. This is on the principle that another station in the group estimated to be fully depreciated in 25 years will probably exist for 35 years and hence will offset the underdepreciation on Station 1575. This practice is consistent with the contention that correct depreciation rates may not be maintained for individual stations but that they can be maintained on an over-all or group basis.

The Group System in Operation

In an article "Practice in Accounting for Depreciation" in Section III of the April, 1941, issue of the *N.A.C.A. Bulletin* it was pointed out that, out of 245 companies questioned, 65 were using group rates for all assets, and another 62 were applying group rates to some but not all of their depreciable property. In other words, approximately one-fourth of the companies to which questionnaires were sent were completely and another one-fourth were partially on the group system. It would be interesting to have the experience of these 127 companies with group rates and the group system. Unfortunately, such information is not available. With this large number of companies making use of the group system,

it is quite natural to ask how one goes about the business of applying the system. Is it equally applicable to small as well as large concerns? Are costs, as computed under the system, reliable? What about the size of the groups? Does the system have any particular disadvantages? Answers to these questions will now be attempted.

Determining the size and nature of the groups is the first and most important step to be taken in installing the group system. Generally, each group should consist of homogeneous property. Judgment must be exercised in determining the degree of homogeneity necessary. For instance, it may be advisable to divide service stations into two groups—one for brick and one for wood construction. It should be remembered, however, that large groups make the system more effective. The chief value of the group method lies in the averaging of service lives, hence the larger the number of units entering into a group, the greater is its significance.

In some instances economic conditions are more important than like physical characteristics in determining the nature of groups. For example, the district equipment in an oil field which may be depleted before the equipment is worn out probably should form one group. This method of grouping has two advantages over the horizontal group:

1. It provides a more natural base for cost distribution, and
2. The Bureau of Internal Revenue allows a retirement loss only when all the equipment within the group is abandoned. In a horizontal group of pumps, for example, no loss could be claimed until the company had retired all the pumps, wherever located.

The need for a fair distribution of costs should always be considered in setting up the various groups. It is possible to use such large and all-inclusive groups that the distribution of depreciation charges is arbitrary. Sometimes, as in the case of cost-plus contracts and joint operating agreements, cost distributions have more than ordinary significance and great care should be exercised in designing a plan for depreciation distribution. Indeed, it may be that rushing headlong into a group system under such conditions would result in the maintenance of additional supple-

mentary depreciation and cost records in accordance with the provisions of the contracts. It is believed that benefits derived from a reduction of clerical work elsewhere might be more than offset by the duplication of work in such cases.

If the detail required for costs is not reduced, there can be no appreciable saving in clerical work by adoption of the group system. Construction of the total depreciation charge for each group by computing the provisions for individual units and totaling them can require little, if any, more work than would be necessary if the total provision were computed for the group and then broken down by operating units for cost purposes.

It should be noted further that under the group method, more may be charged in depreciation than the total investment in that unit. On the other hand, the depreciation charged for some units may be less than the total investment. This condition develops from the fact that only one reserve for the entire group is maintained and depreciation is charged at the established rate until the particular unit is retired.

If a group system is replacing some other, there will probably be a number of pieces of equipment which are fully depreciated. As the depreciation reserve is to be kept for the group as a whole only, the ratio of the investment in a particular unit within the group to the accumulated reserve for that unit will not be known unless memorandum reserve records are kept. Rates which have been determined may be intended to apply only to assets which are not fully depreciated. In this case, it will be necessary to eliminate the cost of fully depreciated items from the base for the depreciation provision.

After the depreciation rates are determined, the application of the group method is more or less mechanical. There may be several rate classes within each group. These rates will be applied to their respective investments and combined to secure a weighted average rate for the group. This may be accomplished by the use of a group plant record similar to that shown in Exhibit 1. In this illustration we have assumed three classes of pumps, each class bearing a different depreciation rate. The weighted average rate is determined by computing the annual depreciation for each rate class and totaling. The per cent of this total to the total investment is the weighted average rate. The August provision

EXHIBIT I

GROUP PLANT RECORD

Pumps and Pumping Equipment

Date	Investment			Rate	Annual Depreciation	Group Depreciation Reserve							Direct Profit (Loss) Items
						Balance at Beginning of Period	Additions		Deductions			Balance at End of Period	
	Balance	Additions	Deductions				Current Provision	Salvage on Retirements	Other	Retirements	Dismantling Cost	Other	
8- 1-41	$ 36,500.00	$	$	6.20%	$ 2,263.00	$	$	$	$	$	$	$	$
8- 1-41	58,200.00			5.75	3,346.50								
8- 1-41	72,300.00			8.40	6,073.20								
	$167,000.00	$	$	7.00%	$11,682.70	71,857.00	973.56						
8-16-41		18,430.00		5.75	1,060.88								
8-16-41			10,100.00	6.20	(626.20)			310.00		10,100.00	190.00		*(7,491.00)
8-17-41			25,000.00	8.40	(2,100.00)					17,870.00			
8-31-41												44,820.56	
9- 1-41	$184,330.00	$	$	6.66%	$10,017.38	41,820.56	834.78						

* Extraordinary retirement due to fire.

Net Book Value	$7,130.00
Removal Cost	1,361.00
Total	$8,491.00
Salvage	800.00
Loss	$7,691.00

of $973.56 is entered under the group depreciation reserve analysis. Note that the provision for each month is computed on the opening balance of the investment so that the book entry for the provision may be made as early in the month as desired. The additional investment of $18,450 in the 5.75 per cent rate class is entered in the additions column of the investment section. The retirement of $10,100 is also set up under the investment section. Note that the full cost of $10,100 is charged to the reserve along with the removal cost. Salvage recovered is credited to the reserve as previously described. The $25,000 retirement is assumed to be extraordinary, in which case the amount of accumulated depreciation only is charged back to the reserve. Effect is given to salvage and removal cost in the computation of the loss of $7,491. Note how the annual provision column is adjusted for the changes in investment so that the balance at September 1 can be divided by 12 to get the September provision.

Under the group system the rates must be carefully watched and adjustments made when it is recognized that rates in use are forcing the group reserves out of line. As a matter of fact, after the system has been put into operation this job of checking the adequacy of reserves looms as the most difficult and intricate remaining. This is the job which will be with us permanently. Determining the accuracy of the rates and the adequacy of the reserves requires us to study the rate of growth and rate of retirements as well as the service lives of the various classes of property. The problem of rate determination is such a difficult and complicated one that we can do little more than touch the simpler phases of it.

Rate Determination and the Group System

The most important, and perhaps the most difficult, phase of the depreciation problem generally is the determination of rates. Depreciation rates can certainly not be safely and conscientiously based upon a foundation of pure guesswork. On the other hand the very nature of depreciation precludes rate determination from the realm of pure fact. The middle ground, where safety and conscience meet practicability, seems to be the use of scientific analysis. This might be said to result in a "guess" made after weighing all the known facts which are in any way related to the

depreciation question. Such a "guess" may be dignified with the name of "estimate."

The inspection method of estimating rates, involving the actual inspection of depreciable property, is perhaps the method having the widest use in American industry. This method, though tainted with suspicion that its "estimates" are pure guesses, is accurate enough when the plant is relatively new or is composed of a few units. As the plant grows in number of units, the suspicion of guesswork becomes more pronounced and the possibility of error proportionately multiplied. With the growth of large concentrations of equipment a search has been instituted for newer, cheaper and more accurate rate methods. This search has run parallel to the search for new methods of depreciation accounting. As the group system has evolved there has grown up with it methods of rate determination to accompany and implement it. Reference is made particularly to the work of Edwin B. Kurtz, E.E., Head of the Department of Electrical Engineering, University of Iowa. His book *Life Expectancy of Physical Property,* published by Ronald Press Company, is believed to be the most valuable contribution to what we have chosen to call the mortality experience theory of depreciation rate determination. Bulletin No. 25 of the Iowa Engineering Experiment Station, edited by Robley Winfrey, M.S., also contains valuable information on this subject. The bulletin is titled "Statistical Analyses of Industrial Property Retirements." The rate aspects of this study have been confined principally to the work of Mr. Kurtz and Mr. Winfrey. Principles underlying the mortality experience theory of depreciation rate determination will first be discussed.

For many years insurance companies have been able to predict with some degree of accuracy the average life span of any large group of individuals. The method by which these insurance companies have been able to estimate the life span so accurately has been built around the theory that a prediction can be based on behavior of like things under similar conditions in the past, provided the scope of observed experience is broad enough and long enough. Disregarding any adjustment for salvage value, a depreciation rate is nothing more than a portion of the life span of physical equipment converted into a percentage. Disregarding salvage again, it follows that all that is needed to accurately deter-

EXHIBIT 2

MORTALITY EXPERIENCE THEORY OF DEPRECIATION RATE DETERMINATION

STATISTICS RE: BEHAVIOR OF A HYPOTHETICAL PLANT ACCOUNT DURING PAST 21 YEARS

Year Additions Made	Cost of Plant Added	Cost of Plant Retired and Age Interval in Which Retirement Made (Age at Retirement)																				Total Plant Cost Retired
		Apr 1/4 Year	Apr 1 Year	Apr 2 Years	Apr 3 Years	Apr 4 Years	Apr 5 Years	Apr 6 Years	Apr 7 Years	Apr 8 Years	Apr 9 Years	Apr 10 Years	Apr 11 Years	Apr 12 Years	Apr 13 Years	Apr 14 Years	Apr 15 Years	Apr 16 Years	Apr 17 Years	Apr 18 Years	Apr 19 Years	Apr 20 Years	
1910	$ 7,050.00	$ —	$ —	$ —	$ 337.00	$ —	$ —	$ 331.00	$ —	$ —	$ 350.00	$ 403.00	$ 1,054.00	$ 235.00	$ —	$ 43.00	$ —	$ —	$ —	$ 7.00	$ 179.00	$ 3,061.00
1911	7,176.00	—	—	—	—	—	66.00	—	786.00	—	93.00	—	—	593.00	—	—	—	339.00	1,250.00	—		3,056.00
1912	9,221.00	—	—	—	—	—	236.00	—	103.00	—	—	—	—	—	—	—	513.00	—	—			852.00
1913	8,864.00	—	—	—	—	—	—	39.00	—	448.00	—	—	—	—	—	—	—	—				487.00
1914	8,956.00	—	—	—	—	—	—	—	—	6.00	—	—	—	—	905.00	—	—	—				911.00
1915	8,452.00	—	—	—	—	—	—	—	—	327.00	—	—	—	—	—	—	—	—				327.00
1916	8,457.00	—	—	—	—	—	—	—	—	—	—	—	—	—	905.00	—	—	—				905.00
1917	6,700.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1918	9,088.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1919	10,334.00	—	—	—	—	—	—	—	—	258.00	—	—	—	—	—	—	—	—				258.00
1920	10,944.00	—	—	—	—	—	—	—	—	—	111.00	—	—	—	—	—	—	—				111.00
1931	9,891.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1932	11,448.00	—	—	—	192.00	—	—	—	—	333.00	—	—	—	—	—	—	—	—				525.00
1933	10,357.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1934	11,791.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1935	12,849.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1936	12,200.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1937	13,800.00	—	—	—	—	979.00	—	—	—	—	—	—	—	—	—	—	—	—				979.00
1938	13,119.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1939	16,459.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
1940	16,734.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—
Total Plant Cost Added	$225,000.00																					
Total Plant Cost Retired		$ —	$ —	$ 192.00	$ 337.00	$ 979.00	$ 302.00	$ —	$ 1,260.00	$ 1,372.00	$ 204.00	$ 550.00	$ 403.00	$ 2,457.00	$ 2,155.00	$ 1,810.00	$ 43.00	$ 513.00	$ 1,589.00	$ 1,250.00	$ 7.00	$ 179.00	$ 12,547.00

mine a depreciation rate is an accurate determination of the life span of the equipment involved. Although the objection might be raised that units of physical equipment are not human individuals, there seems, nevertheless, some basis for drawing a parallel. It is a pretty well established fact that neither human individuals nor units of equipment can exist forever. Therefore, the assumption that broad and long experience with the life histories of equipment units is a definite indication of future behavior is not without some logic. One thing is certain; it cannot be proved definitely that practical application of the theory will produce accurate results nor that it will produce inaccurate results until it has been studied and tested over a substantial period of time.

The application of the theory will be illustrated under three methods; namely, "Composite Original Group Method," "Turnover Method" and "Multiple Original Group Method." Basic information for each of these illustrations is contained in Exhibit 2. This exhibit shows annual additions to a hypothetical plant account over a period of 21 years. It shows also the retirements so arranged as to give effect to the age and to denote the year in which the additions were made.

Composite Original Group Method

This method is just what the title indicates. The word "group" has reference to the additions made during a particular year and not to the group system of depreciation which we have just discussed. The method contemplates that we shall have a composite picture of all the experience with all the groups (the different years' additions) that are available for study. Such experience as reflected by Exhibit 2 is restated in Table I, and percentages shown in the last column thereon are used in plotting the curve on Chart I.

The points which govern the path of the curve represent the per cent of investment dollars which the computation indicates should remain in the aggregate of the groups after they have been in existence one, two, three, etc., years.

When the stub curve is plotted as far as the data permit, it is projected into the future in order to complete the picture. For this purpose we have used a derivation of the Gompertz-Makeham formula, which Mr. Kurtz recommends, by placing on it two

TABLE I

MORTALITY EXPERIENCE THEORY OF DEPRECIATION RATE DETERMINATION

DATA FOR COMPOSITE ORIGINAL GROUP METHOD

Age in Years *	*Plant Cost Subject to Retirement at Beginning of Indicated Age Interval*	*Plant Cost Retired During Indicated Age Interval*	*Remainder—Plant Cost Surviving at End of Interval Which Had Been Exposed to Retirement During Interval*	*Per Cent of Plant Cost Exposed to Retirement During Interval Which Survived*	*Per Cent of Original 100% Surviving at Indicated Age*
¼	$225,000.00	$	$225,000.00	100	100
1	208,246.00	....	208,246.00	100	100
2	191,787.00	192.00	191,595.00	99.9	99.9
3	178,476.00	357.00	178,119.00	99.8	99.7
4	163,099.00	979.00	162,120.00	99.4	99.2
5	150,899.00	302.00	150,597.00	99.8	99
6	137,748.00	....	137,748.00	100	99
7	125,957.00	1,260.00	124,697.00	99	98
8	114,340.00	1,372.00	112,968.00	98.8	96.8
9	102,045.00	204.00	101,841.00	99.8	96.6
10	91,950.00	552.00	91,398.00	99.4	96
11	80,565.00	403.00	80,162.00	99.5	95.5
12	70,196.00	2,457.00	67,739.00	96.5	92.2
13	58,651.00	235.00	58,416.00	99.6	91.8
14	51,716.00	1,810.00	49,906.00	96.5	88.6
15	42,374.00	43.00	42,331.00	99.9	88.5
16	34,206.00	513.00	33,693.00	98.5	87.2
17	25,628.00	359.00	25,269.00	98.6	86
18	16,892.00	1,250.00	15,642.00	92.6	79.6
19	7,275.00	7.00	7,268.00	99.9	79.5
20	3,148.00	179.00	2,969.00	94.3	75
		$12,474.00			

* It is assumed that all additions are made on July 1 and all retirements on June 30, except those retirements occurring in the year of installation which are assumed to be made on Sept. 30 (at age of ¼ Yr.).

restrictions; first, that the surviving percentage at age zero be 100; second, that the rate of decline at age zero be zero. The formula[1] is:

$$Y = G(C^{x}\text{-}x\log_{e}C\text{-}1) \text{ where}$$

Y = Per Cent Surviving

x = Age in Years

e = 2.718+ (Base of Natural Logarithms)

[1] This formula was derived by Dr. M. M. Slotnick of the Geophysics Department of the Humble Oil & Refining Company.

MORTALITY EXPERIENCE THEORY OF DEPRECIATION RATE DETERMINATION
CHART "I"
Survivor Curve and Probable Life Curve
Plotted on Basis of Data Obtained from Table "I" (Composite Original Group Method)
Average Life 35.7 Years
Survivor Curve
Probable Life Curve
Expectancy
Age
Age in Years
Per Cent Surviving
*Data Plots

C and G are constants depending on the equipment used. The equipment determines the points. C and G are determined by mathematical calculation from the points. Using these constants the curve is then plotted.

After the curve is drawn, the first step in determining the average service life of the assets in the group is to compute the area under the curve expressed in per cent-years. The next step is to divide this area by 100 (per cent). This produces the number of years which the average per cent of the asset can be expected to survive when it is new.

It might be important to mention here that as equipment gets older the portion of it which remains in service logically has a life expectancy less than that of new equipment. Beginning with the average service life, which is the life expectancy of new equipment, a curve indicating the expectancy of older equipment can be plotted by determining the average service life at each age in the same manner as for new equipment. The curve can then be drawn through the several points thus obtained, indicating the total probable life of plant at any age as shown by the survivor curve. The horizontal distance between the survivor curve and the probable life curve at any point is the life expectancy of the equipment at that particular age. This feature may add complications, but it is important in computing the average life of old equipment.

Turnover Method

This method derives its name from the fact that the average service life is assumed to be the number of years required to turn over, by retirement and replacement, a given number of dollars invested in plant which was in service on a particular date. There is not necessarily any direct relation between the actual equipment in service on that particular date and the equipment retired since that date. We are dealing here only with dollars.

Information on Exhibit 2 is summarized on Table II for use in illustrating the application of this method, and is self-explanatory.

Referring now to Chart II, it can be seen that the data in the last two columns of Table II govern the path of the curve. The "Year-End Balances" are chartered upward and to the right. The "Retirements Accumulated Backward from Most Recent Year"

TABLE II

MORTALITY EXPERIENCE THEORY OF DEPRECIATION RATE DETERMINATION

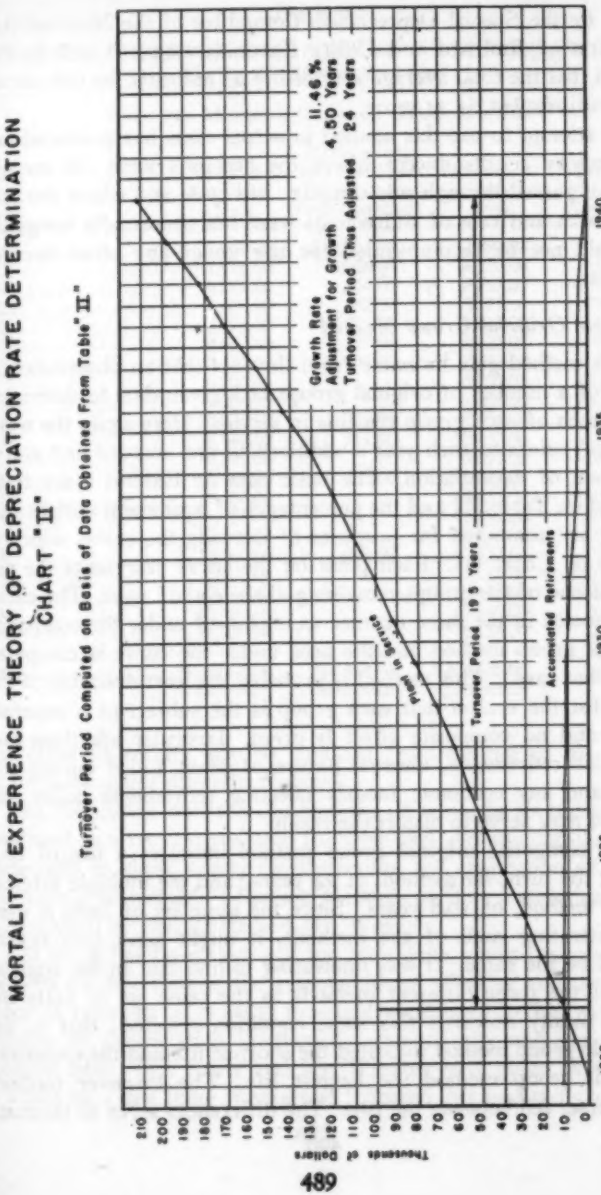
DATA FOR TURNOVER METHOD
(PROVIDING FAIRLY UNIFORM GROWTH)

Year	*Additions to Plant Cost*	*Retirements of Plant Cost (Shown in Year Retired)*	*Year End Balance*	*Retirements Accumulated Backward From Most Recent Year*
1920	$ 7,030.00	$	$ 7,030.00	$12,474.00
1921	7,176.00	....	14,206.00	12,474.00
1922	9,221.00	....	23,427.00	12,474.00
1923	8,864.00	357.00	31,934.00	12,474.00
1924	8,976.00	....	40,910.00	12,117.00
1925	8,452.00	....	49,362.00	12,117.00
1926	8,437.00	66.00	57,733.00	12,117.00
1927	6,700.00	567.00	63,866.00	12,051.00
1928	9,088.00	785.00	72,169.00	11,484.00
1929	10,224.00	105.00	82,288.00	10,699.00
1930	10,944.00	684.00	92,548.00	10,594.00
1931	9,891.00	851.00	101,588.00	9,910.00
1932	11,448.00	1,960.00	111,076.00	9,059.00
1933	10,357.00	1,065.00	120,368.00	7,099.00
1934	11,791.00	192.00	131,967.00	6,034.00
1935	12,849.00	43.00	144,773.00	5,842.00
1936	12,200.00	....	156,973.00	5,799.00
1937	15,020.00	258.00	171,735.00	5,799.00
1938	13,119.00	1,777.00	183,077.00	5,541.00
1939	16,459.00	1,368.00	198,168.00	3,764.00
1940	16,754.00	2,396.00	212,526.00	2,396.00
Totals	$225,000.00	$12,474.00	$2,067,724.00	
Less: 1940 Balance			212,526.00	
Total of Balances to Which Additions Were Made			$1,855,198.00	

AVERAGE RATE OF GROWTH 11.46%

(Net Additions ($225,000.00 — $12,474.00 = $212,526.00) × 100 ÷ Total of Balance to Which Additions Were Made (1,855,198.00)).

are charted upward and to the left to a point where the lines cross. The span of years covered by this accumulated retirement line is the unadjusted "turnover period." This result requires some adjustment in order to compensate for the rate of growth, which is shown at the bottom of Table II. In this case the adjustment is 4½ years and is taken from "service life adjustment curves" pre-


MORTALITY EXPERIENCE THEORY OF DEPRECIATION RATE DETERMINATION
CHART "II"
Turnover Period Computed on Basis of Data Obtained From Table "II"
Growth Rate 11.46 %
Adjustment for Growth 4.50 Years
Turnover Period Thus Adjusted 24 Years
Plant in Service
Turnover Period 19.5 Years
Accumulated Retirements
Thousands of Dollars
Years
1920
1925
1930
1935
1940
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210

pared by the Special Depreciation Committee of the National Association of Railroad and Utility Commissioners. It will be observed that the total average service life as indicated by this curve, after adjustment, is 24 years.

An attempt to use this method in actual cases has produced unsatisfactory results except where the accounts were old enough to have passed through one complete life cycle and where the rate of growth and rate of retirements were not abnormally irregular. It could not be recommended for use under any other circumstances

Multiple Original Group Method

This method gets its name from the fact that an observation is made of a number of original groups at a given date to determine how much of each group remains in service. Here again the word "group" refers to each year's additions to one account and not to a system of depreciation. The basic data on Exhibit 2 are transcribed on Table III and the percentages of equipment dollars surviving are computed for purposes of drawing the curve, which is shown on Chart III. Each point on the curve represents the per cent of one of the groups remaining at the end of 1940. The curve is projected in the same manner as explained under the composite original group method and the area under the curve is computed as in that case. This method is probably the least desirable of the three for the reason that each group is the subject of a separate study and no composite effect is given. Irregular additions and irregular retirements, unusual nature of plant added during any year, and any economic factors affecting retirements under this method may serve to distort the result.

The composite original group method indicates a life of 26.7 years; the turnover method, of 24 years; and the multiple original group method, of 19.8 years. Since the same set of facts is used in illustrating each of the methods, it might seem that results should be the same. It was interesting to find that in the application of the three different methods to the same set of facts for about twenty accounts this same condition resulted; that is, the multiple group method indicated the shortest life and the composite original group method the longest life. The turnover method, of course, fell between the two. The differences serve to illustrate

TABLE III

MORTALITY EXPERIENCE THEORY OF DEPRECIATION RATE DETERMINATION

DATA FOR MULTIPLE ORIGINAL GROUP METHOD

Year	*Additions to Plant Cost*	*Retirements of Plant Cost (Allocated to Year Installed)*	*Balance at End of 1940*	*Per Cent of Dollars Surviving*
1920	$ 7,030.00	$ 4,061.00	$ 2,969.00	42.23
1921	7,176.00	3,056.00	4,120.00	57.41
1922	9,221.00	854.00	8,367.00	90.74
1923	8,864.00	487.00	8,377.00	94.51
1924	8,976.00	911.00	8,065.00	89.85
1925	8,452.00	327.00	8,125.00	96.11
1926	8,437.00	905.00	7,532.00	89.27
1927	6,700.00	....	6,700.00	100.00
1928	9,088.00	....	9,088.00	100.00
1929	10,224.00	258.00	9,966.00	97.48
1930	10,944.00	111.00	10,833.00	98.99
1931	9,891.00	....	9,891.00	100.00
1932	11,448.00	525.00	10,923.00	95.41
1933	10,357.00	....	10,357.00	100.00
1934	11,791.00	....	11,791.00	100.00
1935	12,849.00	....	12,849.00	100.00
1936	12,200.00	979.00	11,221.00	91.98
1937	15,020.00	....	15,020.00	100.00
1938	13,119.00	....	13,119.00	100.00
1939	16,459.00	....	16,459.00	100.00
1940	16,754.00	....	16,754.00	100.00
Total	$225,000.00	$12,474.00	$212,526.00	

that different results may be obtained from the use of the same set of facts under different methods.

This discussion and the illustrations of methods should not be construed as a recommendation for their use. An attempt has been made only to show briefly by illustration the application of what may rightly be termed "Scientific Methods of Rate Determination" as developed by Mr. Kurtz and Mr. Winfrey.

Too much has been said, and too little done, about depreciation, methods of determining the reasonableness of rates and the adequacy of reserves. It is about time that we attempt to deal with the problem of depreciation intelligently, scientifically and yet along practical lines. Mr. Kurtz and Mr. Winfrey have given us a lead. It would be a fine thing if someone followed this lead to its logical

MORTALITY EXPERIENCE THEORY OF DEPRECIATION RATE DETERMINATION
CHART "III"
Survivor Curve and Probable Life Curve
Plotted on Basis of Data Obtained from Table "III" (Multiple Original Group Method)
Average Life 19.8 Years
Survivor Curve
Probable Life Curve
Expectancy
Age
Age in Years
Per Cent Surviving
Data Points

conclusion. Determine if it is the answer to our depreciation rate problem. If it is, we can certainly afford to do whatever is necessary to adapt ourselves to its use.

Group Depreciation and Federal Income Taxes

Observations with respect to depreciation as a tax deduction or a discussion of the policy of the Bureau of Internal Revenue in dealing with allowances for depreciation must of necessity be general. There seems to be nothing definite about tax depreciation except some very general statements appearing in the Regulations. All revenue laws have provided for a reasonable allowance for depreciation, and regulations have prescribed in general "methods of computing depreciation allowances." Some of the common expressions found in the regulations prior to the issuance of Treasury Decision 4422 were:

1. The capital sum (the cost) should be written off during the useful life of the property.
2. The method must be reasonable and must have due regard for operating conditions, etc.
3. While the burden of proof must rest upon the taxpayer to sustain the deduction, such deduction will not be disallowed unless shown by clear and convincing evidence to be unreasonable.
4. If it develops that the useful life as originally estimated was wrong, then the undepreciated balance should be spread over the remaining useful life of the property.

It may be noted particularly that under these provisions, before any disallowance can be made, the Commissioner must show that the amount claimed as depreciation is unreasonable and that any error in estimating useful life may be adjusted when discovered and over- or under-depreciation may be absorbed in subsequent years.

In Treasury Decision 4422, however, these important provisions were changed and new ones added. The burden of proof is placed "squarely upon the taxpayer" to substantiate the amount claimed, and under-depreciation in past years cannot be claimed in subsequent years. The new provisions have to do with the preparation of detailed information and the suggested form of schedules which may be used. They also provide that under certain conditions ordinary retirements should be charged to the depreciation reserve account.

A search of the regulations fails to reveal any definite requirements as to forms, systems or methods which should be used. The Bureau usually tells taxpayers that it is not the policy of the Bureau to say how depreciation should be computed, in what form it should be submitted, or what rates it will accept for any class of property. But in actual practice we have a different picture. When our returns are being examined, we can then observe the application of Bureau policy. Examining agents will discuss rates, their determination and application. They will examine your depreciation schedule and advise with you as to methods which might produce different results. But in judging as to the reasonableness of the amount claimed, their examination will be confined to groups or large classes of property. They will take notice of the resulting or effective rate of depreciation and will judge such rates by the ratio of reserve to investment and the rapidity of growth of this ratio. You will be told that no one, not even an engineer, can reasonably estimate the service life of a property from inspection and that your experience over a long period of time with a large group of properties should govern in determining rates. You may be told, also, that when the ratio of depreciation reserve to the investment reaches 50 per cent, the rate should be reduced.

It is doubtful whether such methods are contemplated in the regulations. The term "the property" is used throughout that part of the regulations having to do with the "basis," "useful life," and the "condition." The language "properties," "group of properties," or "a collection of assets" does not appear in any income tax ruling or regulations except in Treasury Decision 4422, and there it is stated that "assets may be segregated into groups if it was necessary in determining depreciation." This has reference to segregation rather than a consolidation into groups. It would seem, therefore, that the regulations contemplate that each property should be dealt with for depreciation purposes in the light of circumstances and conditions under which it exists. We find that in a large number of court decisions dealing with depreciation each property is dealt with separately and not by groups.

It is not my purpose to criticize the Bureau or its depreciation policy; on the contrary, the Bureau deserves commendation for its efforts along progressive lines to develop a yardstick for measuring depreciation.

The purpose of these observations is to show generally the Bureau's attitude toward the group system of depreciation. Those of the Bureau whose duty it is to administer the depreciation provisions of the law very definitely favor it, but unofficially. Apparently their reason for so doing is that the policy of charging retirements to the reserve account can be more easily justified and that the examination of returns can be facilitated by the application of so-called scientific methods of determining rates and of judging the adequacy of reserves.

We can have no quarrel with the Bureau about the application of these scientific methods provided they apply to conditions or contemplate the particular circumstances in the individual case. Scientific methods work well in hypothetical cases but often they serve only to confuse in their practical application.

One of the so-called scientific methods proposed by the Bureau for testing the upper limit of accrued depreciation reserves under the group system was first developed by a special committee on depreciation of the National Association of Railroad and Utility Commissioners. This committee prepared a chart with curves showing the per cent at which the reserve for depreciation should become stabilized at different rates of growth. At an annual rate of growth of 20 per cent and a depreciation rate of 10 per cent, the chart shows that the reserve should not exceed 34 per cent of the investment. Where the growth is nil and the rate is 10 per cent, the curves show that reserve should not exceed 46½ per cent. Where the rate is 5 per cent per annum, the chart shows that the reserve should stabilize from 46½ per cent to 26½ per cent depending on rate of growth. An application of the principles of this chart to our business has been found to give misleading results. Particularly is this the case where the retirement history or the rate of growth was irregular. Under certain conditions, we agree, there is a point where reserve for depreciation in relation to investment should become stabilized; but just where, no one can say without a thorough and painstaking study of the plant involved and the rate of growth and the rate of retirement.

It is my feeling, however, that whether we agree with any of the proposed methods of determining the rates or for testing the adequacy of the reserves, we have a duty to the Government and

industry to co-operate with the Bureau of Internal Revenue in its effort to find a reasonable answer to the depreciation problem.

Conclusions

It is never wise to be too positive in drawing specific conclusions where depreciation is concerned. Particularly is this true with as controversial a subject as the group system of accounting for depreciation. There are, however, by way of summary, some general conclusions which may be mentioned for what they are worth; namely:

1. The group system is not applicable universally. Size of the company, number of like units of property, nature of the business, information required by management and numerous other factors must be considered in determining whether the system can or should be installed in any particular organization.

2. Some practitioners, while condoning the group system, feel that it neither provides more scientific accounting nor more accurate scientific facts than other systems. As expressed by one accounting authority, "it is a make-shift which carries with it a shiftless trust in the happy outcome of things."

3. It is believed that this position, while correct in some instances, does an injustice to the system in its entirety. It is believed, further, that in those cases where (a) the respective groups include properties which are homogeneous, (b) rates applied are adequate and accurate to a degree possible of attainment, and (c) sufficient detail is maintained to provide for a continuous analysis and revision of group rates, the system provides reliable depreciation costs and results in a more significant and comprehensive accumulated reserve.

4. While an indiscriminate grouping is to be frowned upon, the groups should be as large as practicable and as broad as the requirements of cost accounting will permit. In the practical application of the size and comprehensiveness of the groups, consideration must be given to operating conditions, climatic conditions, and, perhaps, products manufactured.

5. In those concerns having large numbers of similar properties, it appears that the group system is favored over other systems by the Internal Revenue Department.

6. The more recent scientific methods of rate determination appear to have been developed in connection with the group system. This would seem to indicate that large groups of assets are susceptible to more scientific analysis than individual units. Should this be found to be true, then a higher degree of reliability may be attached to depreciation on the group system than has been the case previously.

7. The adoption of the group system by a particular company does not imply its use to the exclusion of other systems of depreciation. While consistency and uniformity in method are virtues devoutly to be desired, they should not take precedence over the practical exigencies of any given situation. Accounting principles are, therefore, not impugned through the use of unit, composite and group systems, all within one enterprise.

Lest Old Acquaintance Be Forgot

Once again the Yuletide Season is upon us and with it the spirit of goodfellowship and friendly greetings.

May we, your convention committee, pause momentarily in our planning to wish you and yours—

A Merry Christmas and a Prosperous and Happy New Year

What better time or place is there to make new acquaintances and kindle the fires of old friendships than the Annual NACA Convention.

We'll be waiting with our hand outstretched to greet you

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